Kinematic Viscosity Measurement of In-Service Oils

Relevant for: Used oil analysis labs, companies operating industrial or construction machinery, lube R&D, fleet maintenance.

SVM 1001 provides quick and easy measurements of in-service oils. The instrument helps to ensure machinery health and save cost and time by monitoring the oil's condition and identifying the right time for an oil exchange.

1 Introduction

Viscosity is an important parameter for oil condition monitoring. Based on the difference in kinematic viscosity between fresh and used lubricant, in-service oil analysis can provide information on the wear condition of the machinery/equipment, as well as the contamination and condition of the lubricant. The benefits of used oil analysis are increased reliability and productivity, and savings in maintenance costs by increasing the uptime of running machines. OCM (Oil Condition Monitoring) also helps to avoid unwanted and costly downtimes due to damage to machinery.

The SVM 1001 viscometer enables quick and easy measurements of kinematic viscosity according to standard test method ASTM D7042. One compact measuring cell, short time-to-result and liquid-free thermostatting combined with the optional magnetic particle trap makes SVM 1001 an excellent alternative to conventional glass capillary systems.

1.1 SVM 1001 – user benefits

The SVM 1001 is perfectly suited for viscosity measurements of in-service oils. The instrument provides several advantages compared to glass capillary viscometers:

- Saves cost and time thanks to short measuring times and higher sample throughput (up to 37 samples/hour).
- Peltier temperature control makes additional equipment like external thermostatic bath and thermometers unnecessary.
- Measurement over a wide viscosity range with only one measuring cell (0.3 mm^2/s to 5 000 mm^2/s).
- Digital data handling avoids data loss and errors during transcription.
- Three years of warranty and after sale support.

1.1.1 Measuring temperature

SVM 1001 provides fast temperature control and equilibration and excellent temperature accuracy over a wide temperature range thanks to Peltier thermostatting technology.

The viscometer is designed to operate at one or – optionally – two pre-defined, fixed temperatures in the range of 15 °C up to 100 °C. Typical temperatures for the analysis of in-service oils are +40 °C and +100 °C.

Tip: You can find more information about the calculation of other relevant parameters, such as the viscosity index on Anton Paar's Wiki page: wiki.anton-paar.com

1.1.2 Magnetic particle trap (MPT)

This accessory is recommended for measurements of in-service oils and other samples that may contain ferromagnetic particles that settle on the magnetic inner rotor. This affects the rotor speed and, thus, the measurement results. The MPT is electrically heated to a temperature of approx. 80 °C, which reduces the viscosity of the samples during filling and optimizes the removal of ferromagnetic particles.

The MPT is easy to operate as it can be mounted by a simple plug-in mechanism. Cleaning the magnetic particle trap is also fast and straightforward, as the magnet never comes into direct contact with the sample.

Tip: Information about the measuring principle can be found on our Wiki page: https://wiki.anton-paar.com/us-en/basic-of-viscometry/astm-d7042/

Note: It is not possible to combine the Simple Fill funnel with the MPT. When using the Simple Fill mode, magnetic particles need to be removed during sample preparation, e.g. with a magnetic rod.

2 Sample and sample preparation

Sample preparation of used oils depends on their source and condition (age, degree and type of contamination, etc.). It is recommended that only the minimum necessary sample preparation steps are carried out, as each preparation step can influence the viscosity. To avoid segregation of particles, viscosity measurement should be performed promptly after preparation.

2.1 Homogenization

In-service oil can contain particles, but also cooling liquid, fuel or condensed water. Therefore, it is important to homogenize each sample before measurement. This can be done by stirring the original container at low speed for about five to ten minutes.

Tip: Contamination of the oil with gassing components can lead to problems at higher measuring temperatures (e. g. 100 °C). For successful measurements, the class “ultrafast” is recommended to avoid measuring problems resulting from bubble formation.

2.2 Removal of large solid contaminations

Contaminants from in-service oils may include metal swarfs or solid combustion residues. These solid contaminants should be removed if they exceed a maximum particle diameter of 200 µm.

(ASTM D7042 and D445 recommend removing particles larger than 75 µm). Remove these particles using a sieve with a suitable mesh size or a filter with an appropriate aperture.

Tip: Do not remove particles smaller than the specified particle diameter as this falsifies the measurement results.

2.3 Sample

In this application report the kinematic viscosity of three different in-service oils was measured and compared to data from ASTM D445 and D7279 measurements.

Table 1: In-service oil samples.

Sample	Description
ISDO 1203	In-service diesel engine oils from ASTM proficiency testing program (PTP).
ISDO 1207	
ISDO 1407	

3 Measurement

3.1 Measuring Settings

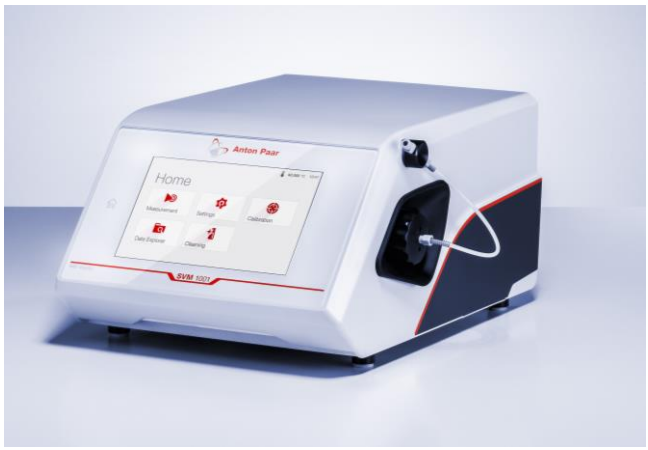

Figure 1: SVM 1001

Figure 2: SVM 1001 with MPT.

Table 2: Measurement settings for typical measuring temperatures of in-service oils.

	Kinematic Viscosity at 40 °C	Kinematic Viscosity at 100 °C
Measurement Mode*	D7042	Single measurement
Prewetting	on	on
Num. of determinations	5	1

* The "class" (“precise” for D7042 mode and “ultrafast” for Single measurement mode) is automatically determined by the selection of the measurement mode.

3.2 Cleaning procedure

The cleaning procedures for in-service oils include two-step cleaning with different cleaning liquids. The prewash significantly improves the cleaning performance of samples with high soot content or other sticky solid contaminants.

Two cleaning liquids:

1. The first cleaning agent is used as a carrier substance to remove particles and contaminations. Suitable liquids are diesel fuel/kerosene or low-viscosity oils.
2. The second solvent is used to clean and dry the measuring cell. The quality of the solvent must be "chemically pure" or "for synthesis". Suitable liquids are petroleum benzine or a mixture of toluene and isopropyl alcohol.

Tip: For samples with different contaminations, an efficient cleaning mixture of three solvents can be used: toluene + isopropyl alcohol + petroleum benzine in a ratio of 40:30:30.

4 Results

ASTM PTP in-service diesel oil samples were measured at 40 °C and 100 °C using the SVM 1001 with MPT. The values obtained were compared with the stated kinematic viscosity data (according to D445 and D7279) from the data sheet provided by ASTM.

Table 3: Measuring results D445 and D7042 at 40 °C

In-service oil	D7042 (SVM 1001) [mm²/s]	D445 [mm²/s]	Deviation [%]
ISDO 1203	106.2	105.8	-0.34
ISDO 1211	98.61	98,40	-0,22
ISDO 1407	65.60	65.35	-0.38

Table 4 Measuring results D7279 and D7042 at 40 °C

In-service oil	D7042 (SVM 1001) [mm²/s]	D7279 [mm²/s]	Deviation [%]
ISDO 1203	106.2	105.7	-0.48
ISDO 1211	98.61	98.21	-0.40
ISDO 1407	65.60	65.26	-0.53

Table 5: Measuring results D445 and D7042 (class: ultrafast) at 100 °C

In-service oil	v (SVM 1001) [mm²/s]	D445 [mm²/s]	Deviation [%]
ISDO 1203	14.41	14.19	-1.61
ISDO 1211	13.92	13.65	-1.95
ISDO 1407	10.55	10.46	-0,86

Table 6: Measuring results D7279 and D7042 (class: ultrafast) at 100 °C

In-service oil	v (SVM 1001) [mm²/s]	D7279 [mm²/s]	Deviation [%]
ISDO 1203	14.41	14.27	-1.03
ISDO 1211	13.921	13.75	-1.20
ISDO 1407	10.55	10.53	-0.11

4.1 Sample throughput - D7042 vs D445 and D7279

A typical manual D445 test takes about one hour. In an optimal case, an experienced operator can perform more than one test at a time. However, if several viscometers are placed in one bath, it is forbidden to add and/or remove a capillary from the bath during the measurement. Therefore, manual capillaries allow the measurement of a maximum of two samples per hour.

As the SVM 1001 has much shorter temperature equilibration, measurement and cleaning times and can achieve much higher sample throughput with minimal operator time. Measurements in the “Single measurement” mode (class "ultrafast”), and optimized filling and cleaning provide a throughput of up to 37 samples per hour.

Furthermore, SVM 1001 is significantly more economical in terms of initial investment cost, solvent and energy consumption.

5 Conclusion

The SVM 1001 is ideal for determining the kinematic viscosity of used oils or in-service oils. The device enables fast kinematic viscosity measurements with accurate temperature control without a thermostatic bath, which significantly reduces costs and time.

The easy filling and cleaning of the robust metal measuring cell makes the SVM 1001 an excellent alternative to standard glass capillaries. Aside from providing excellent sample throughput, SVM 1001 is also very cost-efficient.

Anton Paar offers a Return On Investment (ROI) calculator which compares typical costs for manual viscosity measurements according to ASTM D7042 standard (implemented by SVM) compared to ASTM D445 instrument types. Costs are separated into investment costs and Total Costs of Ownership (TCO) comprising operational costs as well as maintenance costs. Ask your sales representative for a comparison.

6 References

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2. https://www.anton-paar.com/corp-en/services-support/document-finder/application-reports/automated-viscosity-measurement-of-in-service-oils/
3. https://wiki.anton-paar.com/at-de/viskositaetsindex/
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5. ROI_Calculator_D7042

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